# Synchronous and asynchronous tools in online teaching and assessment: Evaluation of impact on assessment results for subject Thermal Renewable Energies of the Degree in Energy Engineering at UPV during 2019-2021

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*Abstract*

COVID-19 pandemic made necessary to change from face-to-face to online teaching and evaluation. In this paper, the impact on the assessment of online teaching using synchronous and asynchronous lectures and the comparison with the traditional course is analyzed. Regarding online exams, performed with PoliformaT platform, assessment results were significantly better than traditional face-to-face methods, even if examination times were reduced by about 30%.

**Keywords:** Online teaching, asynchronous teaching tool, synchronous teaching tool, face-to-face evaluation, online evaluation.

*Resumen*

La pandemia COVID-19 hizo necesario cambiar de enseñanza presencial a enseñanza en línea. En este trabajo se muestra el impacto en la evaluación de la aplicación de la enseñanza en línea mediante clases síncronas y asíncronas, y la comparación con el curso tradicional.

En cuanto a los exámenes en línea, realizados con la plataforma PoliformaT, los resultados de evaluación fueron significativamente mejores que los métodos presenciales aunque los tiempos de examen se redujeron en aproximadamente un 30%.

**Palabras clave:** Docencia en linea, herramienta de docencia sincrona, herramienta de docencia asincrona, evaluación presencial, evaluación no presencial.

## 1. INTRODUCTION

COVID-19 situation in Spain in 2020 forced the implementation of online teaching and evaluation. Due to the prohibition of face-to-face meetings, educational institutions stopped their traditional classroom academic activities on March 15, 2020. However, at universities (and other educational centers) of the Valencian Community, it was decided to continue the university activity through online teaching. Specifically, in Universitat Politècnica de Valencia, there were already available tools and platforms that allowed a rapid transition. Regarding Sustainable Development Goals, online teaching is a powerful strategy to guarantee quality education (SDG 4) in different scenarios (emergency situations like COVID-19 or Ukraine war, or countries with limited educational resources).

Synchronous and asynchronous teaching tools are known and already widely used due to COVID-19 pandemy. Synchronous tools are virtual tools for direct interaction (in real-time) between professors and students. Asynchronous teaching tools allow teaching material to be available for students and can be consulted at any time. This material can be videos, books, presentations, etc.

In this paper, the assessment results of the online methodology applied to a traditional face-to-face course are shown. The selected subject is Thermal Renewable Energies of the Energy engineering Degree at the Universitat Politècnica de València.

## 2. METHODOLOGY

In this section, the methodologies for synchronous and asynchronous lecture are briefly described. The methods for synchronous classes are shown in figure 1, and asynchronous courses are included in Figure 2.

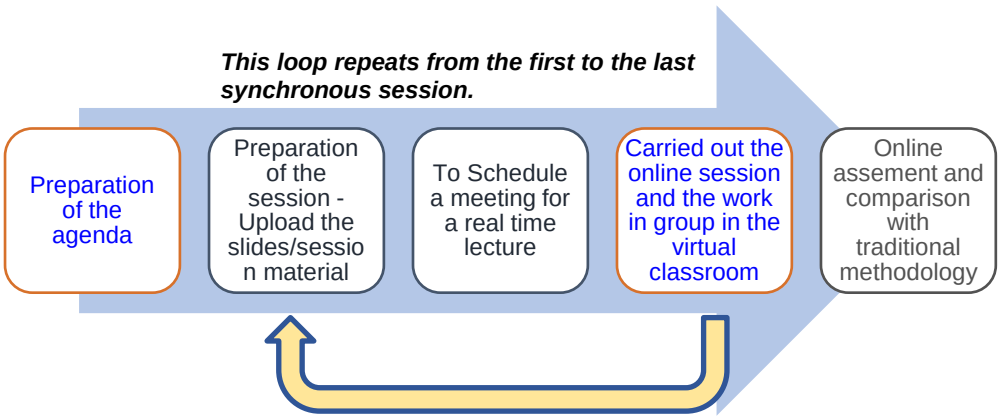


*Fig. 1 Methodology for the synchronous lectures*
*Source: Argente, 2016; ASIC – UPV, 2020; Peña, 2019; Vargas-Salgado, 2021*

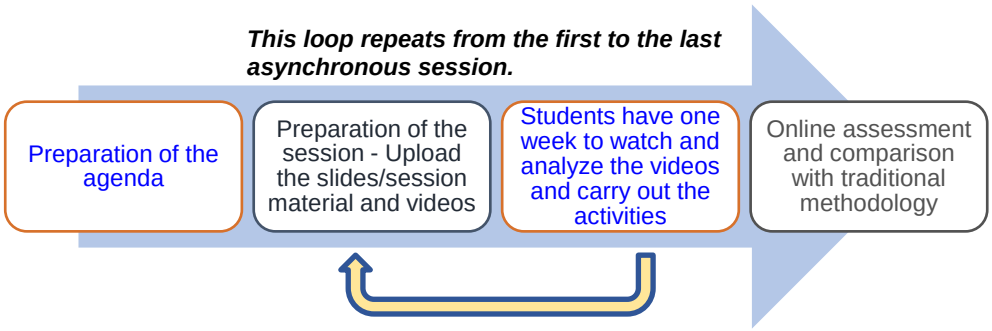


*Fig. 2 Methodology for the asynchronous lectures.*
*Source: Argente, 2016; ASIC – UPV, 2020; Peña, 2019; Vargas-Salgado, 2021*

## 3. ASSESSMENT

In the traditional face-to-face evaluation (applicable in 2019 and 2021), the exam consists of three parts: 1 multiple-choice-test (10 questions), two practical problems, and a question to develop by the student. The exam is carried out through the traditional method in paper and at the classroom. For the online (non-face-to-face) assessment the exam is performed by employing the Exam tool, available in PoliformaT. The test and the problems were previously designed. In the case of the practical problems, the students had to send the numerical results, and additionally, they must upload a picture of the problem solution (Table 1). The total examination time was reduced by a 30%.

*Table 1: comparison between the online and conventional evaluation.*

| *Exam* | *Traditional (2019)* | *Online (2020)* | *Traditional (2021)* | *Time reduction (online respect to traditional)* |
|---|---|---|---|---|
| **Multiple choice test** | 10 questions, 15 minutes | 10 questions, 7 minutes | 10 questions, 15 minutes | 53% |
| **Practical problem 1** | 40 min | 25 min | 40 min | 37.5% |
| **Practical problem 2** | 35 min | 25 min | 35 min | 31.5% |
| **Practical problem 3** | - | 20 min | 20 min | 0% |
| **Questions** | 1 question (20 min) | - | - | |
| **Total** | 110 min | 77 min | 110 | 30% |

In summary, it can be observed that a bigger time reduction was made for the multiple-choice test (53% time reduction), where the total time for ten questions was 7 minutes, so 42 seconds per question. In this test, it must be noted that the order of appearance of the questions is different (random) for every student. Regarding the practical problem, time was reduced by about 31-38% for two out of three, and there was no time reduction in the third one.

The following pictures include an example of the test in figure 3 and part of a problem in figure 4.

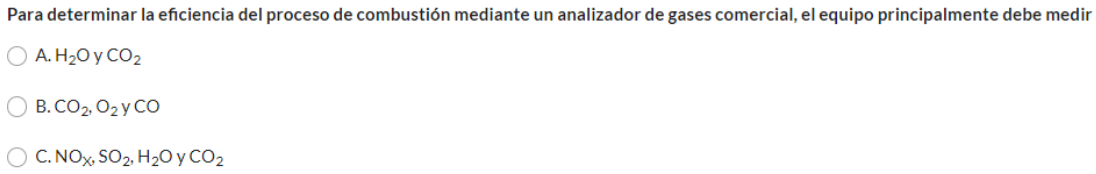


*Fig. 3. Test question example.*

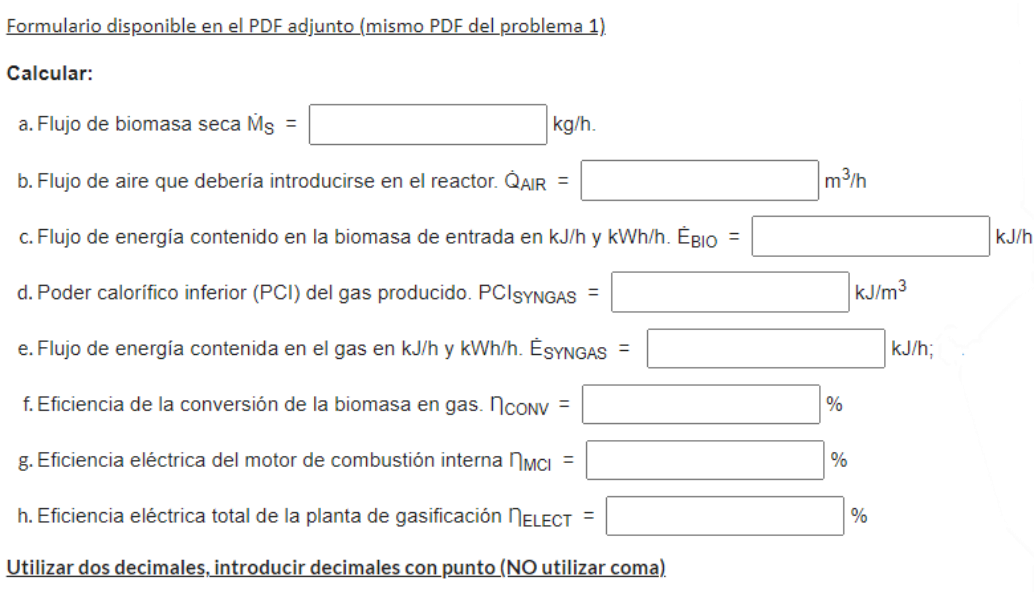


*Fig. 4. Practical problem example.*

## 4. USED TEACHING TOOLS

The tools used are open-source software, UPV developing tools or UPV has the license.

### 4.1. Synchronous teaching tool: MS Teams

The synchronous tool used in this method is MS Teams which allows virtual meetings, chats, file sharing, and screen sharing. The UPV has the license for the whole university community. MS Teams is used for synchronous virtual online teaching; however it can also be used for asynchronous teaching and tutoring as it allows recording; therefore, the students can watch the videos later to review the lectures (Chiñas-Palacios, 2019; *Vargas-Salgado, 2021*).

### 4.2. Asynchronous teaching tools

Asynchronous teaching tools allow flexible access to lecture contents for students (they can access at any time). Thes contents can include videos, books, slides, etc. The used tools are UPV's asynchronous tools and external open-source or licensed tools. The asynchronous tools used in this methodology are described in previous publications (*Vargas-Salgado, 2021)*

The UPV asynchronous platform is PoliformaT; it is used to share documents, send messages to students, take tests, etc. Also integrated into PoliformaT, the Lessons tool is used to create, access and organize contents in a more friendly and intuitive way(Gómez-Tejedor, 2019).

To disseminate videos, there are two options: UPV media and Microsoft Stream. Media UPV is the UPV platform to share videos by sharing links with students. Additionally, video links can be embedded in the Lessons tool so students can access them easily.

## 5. RESULTS

### 5.1. Traditional and online sessions – comparison of assessment results

Table 2 compares the 2019 and 2021 conventional assessment results with the 2020 online evaluation method. As a result, the average mark increased from 5.6-5.9 (traditional evaluation) to 7.3 (online evaluation).

Figure 3 shows (from highest to lowest), the marks of all the students of the traditional courses and the online course. It can be noticed that in the online evaluation, the marks are higher.

*Table 2. Average, maximum, and minimum marks. Traditional evaluation method vs. Online method*

| Mark | 2019 | 2020(*) | 2021 |
|---|---|---|---|
| Average | 5.9 | 7.3 | 5.6 |
| Maximum | 9.9 | 9.8 | 9.7 |
| Minimum | 1.5 | 2.7 | 1.6 |
| Not presented | 7.3% | 9.4% | 13.2% |

(*) Online method

Partial results of the exam (separately multiple choice test and practical exercise) is also included in the following table:

*Table 3. Partial results of the exam*

| Exam part | 2019 | 2020(*) | 2021 |
|---|---|---|---|
| Multiple choice, average mark | 6.7 | 6.5 | 6.6 |
| Practical exercise, average mark | 5.7 | 7.7 | 4.9 |

(*) Online method

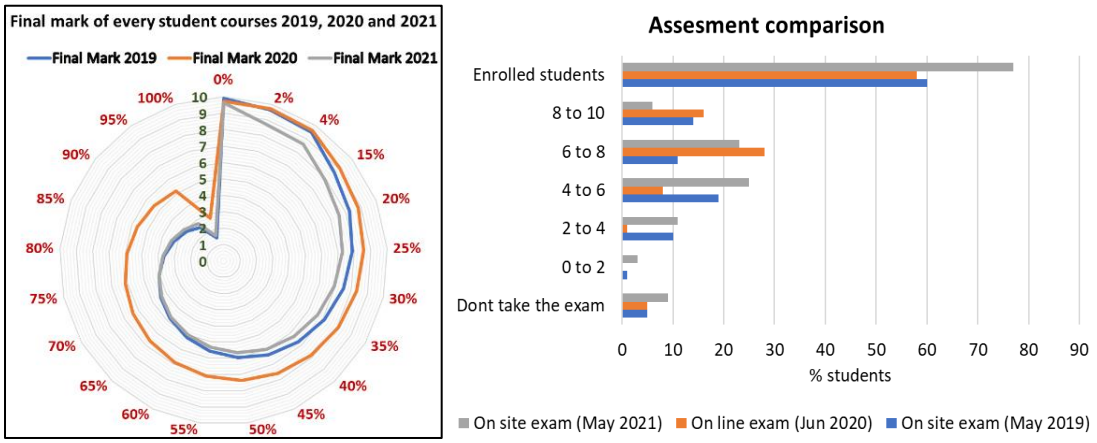


*Fig. 3. Comparison of the assesment results.*

It can be observed that multiple-choice results are very similar independently of online or traditional methods. However, probably due to longer time availability (compared to the test) and the impossibility of controlling the student's access to the subject teaching material in the

practical exercise, an increment of about 35-40% on the average mark in this part of the exam was obtained.

## 6. CONCLUSIONS

Due to COVID-19, more intensive use of online teaching was necessary. There was no single tool that integrates every necessity into one, so multiple applications were used. If any of these applications have never been used, it can take time and effort to choose them and learn how to use them. This document presents the experience of using various tools that allow synchronous and asynchronous teaching, saving time in selecting these tools. Due to the state of alarm caused by the COVID-19 pandemic, these tools have been applied to Thermal Renewable Energy Course. It can be concluded, not only by the results of this work but according to the experience of the UPV, that it is possible to carry out online teaching, but further improvements could be made for assessment purposes.

The results of the evaluation of the 2019 and 2021 courses have been compared with the results of the 2020 course (online method). Although the examination time was reduced to partially avoid reading the class material and the difficulty of the exam was similar, the average mark increased from 4.9-5.9 to 7.3. It was impossible to control if the student was reading the course material. The higher average mark is probably related to the possibility of consulting course teaching material. Looking at the different parts of the exam, it can be concluded that the results were similar in the three years for the part of a multiple-choice test. Still, for the practical exercise, which typically requires more time, the assessment results were 35-40% higher for the online examination performed in 2020.

In future works, further improvements should be studied to guarantee equality for all the students and control the access to subject teaching materials or additional strategies to indirectly avoid this, for example, more aggressive time reduction or cam observation.

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